1 504 063

PATENT SPECIFICATION

(11) 1 504 063

(21) Application No. 1044/76 (22) Filed 12 Jan. 1976
(31) Convention Application No. 50/006856
(32) Filed 14 Jan. 1975
(31) Convention Application No. 50/006855
(32) Filed 14 Jan. 1975
(31) Convention Application No. 50/006854
(32) Filed 14 Jan. 1975
(31) Convention Application No. 50/064314U
(32) Filed 16 May 1975 in
(33) Japan (JP)
(44) Complete Specification published 15 March 1978
(51) INT CL² A47L 9/20//5/22 9/10 9/26 B65H 75/42
(52) Index at acceptance
A4F 11A3A3 12D 12J 12L 12X
B1T 331 361 421 543 661 66Y 699 713 762 764
B8M 8C B3

(19)

(54) A VACUUM CLEANER

(71) We, HITACHI, LTD., a Corporation organised under the laws of Japan, of 5-1, 1-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a vacuum cleaner comprising means for automatically removing dust cleaning to a filter by utilizing the turning force of an electric cable reel.

With prior art vacuum cleaners of this type, it has been proposed to operate a dust removing mechanism upon drawing and winding a length of electric cable from or around a cable reel. However, such proposal suffers from a short coming in that a coil spring capable of exerting a large amount of torque is required to wind the cable around the cable reel with the result that the force needed to draw the cord out of the cord reel is increased. For this reason, the dust removing mechanism is operable only upon drawing out a cable from the reel, and is inoperable upon winding the cable around the reel so that the spring built in the cable reel is used only for the purpose of winding the cable around the reel. However, the cable is normally drawn from the cable reel prior to starting up cleaning, so that the dust clinging to the filter during the cleaning can not automatically be removed after the completion of cleaning with the cleaner of the above-mentioned construction. Accordingly, in order to efficiently remove the dust clinging to the filter, it is desirable to remove the dust from the filter both upon drawing and winding a cable, that is, before and after the cleaning operation.

It is an object of the present invention to provide a vacuum cleaner which can automatically remove dust clinging to a filter upon drawing and winding a cable without the need for increasing the torque exerted by a spring built in a cable reel.

According to the present embodiment there is provided a vacuum cleaner comprising a dust case having an air-intake opening; a main body case having an air exhaust opening; means releasably locking together said dust case and said main body case; a filter received within said dust case; an electric blower received within the main body case and adapted to introduce an air flow into said air intake opening through the filter and out of the air exhaust opening; an electric supply cable reel received within said main body case and biased in a winding direction by means of a coil spring; a dust removing means for removing the dust clinging to said filter; and a transmission means for transmitting motion of said cable reel, produced upon winding and drawing out said cable, to said dust removing means; said dust removing means having a dust removing element which rotatively slides on a back surface of said filter to remove the dust clinging to said filter, the transmission means and the dust removal means being constructed such that the rotational speed of said dust removing element is smaller than that of said cable reel.

An embodiment of the present invention will now be described by way of example with reference to the accompanying drawings, in which:—

Fig. 1 is a longitudinal cross-sectional view of a vacuum cleaner according to the present invention;

Fig. 2 is an exploded perspective view of a dust case section;

Fig. 3 is an exploded perspective view of a body case;

Fig. 4 is a cross-sectional view of a cable reel assembly;

Fig. 5 is an exploded perspective view of the cable reel assembly;

Fig. 6 is an enlarged perspective view of a coupling section;

Fig. 7 is an enlarged cross-sectional view showing the coupling section in an engaged condition;

Fig .8 is an enlarged cross-sectional view taken along a line I—I of Fig. 1;

Fig. 9 is a cross-sectional view taken along a line II—II of Fig. 8;

Fig. 10 is an enlarged view of the coupling section of Fig. 1;

Fig. 11 is a perspective view of a packing;

Fig. 12 is an enlarged view of a filter device;

Fig. 13 is an enlarged perspective view of part of the filter device of Fig 12;

Fig. 14 is an enlarged view taken along a line III—III of Fig. 2;

Fig. 15 is a plan view showing the operation of the filter device of Figures 12 and 13.

Fig. 16 is a view showing the operations of the dust removing means and a transmission means;

Fig. 17 is a view showing the operation of a dust removing element;

Fig. 18 is a cross-sectional view of the dust removing element;

Fig. 19 is a view showing the operation of a prior art dust removing means;

Figs. 20 and 21 are plots showing the relationship between the dust collecting capacity and suction force;

Fig. 22 is an enlarged view of a filter body;

Fig. 23 is an enlarged diagrammatic view of a prior art filter body;

Fig. 24 is a partial diagrammatic view showing a filter body used in a vacuum cleaner according to the present invention; and

Fig. 25 is a partial diagrammatic plan view showing the operation of the prior art filter body of Fig. 23.

Referring to Figs. 1 and 3, there is shown at 1 a main body case made of a synthetic resin. The case 1 is of a split type, and thus consists of a lefthand case portion 1b and a righthand case portion 1a, and is formed integrally with a first handle 2. Shown at 3 and 4 are ribs which are provided in facing relation to each other within the lefthand and righthand case portions 1b, 1a, and serve to divide the interior of the case 1 into a chamber 5 for an electric blower, a chamber 6 for a cable reel, and an exhaust chamber 7. Rubber cushions designated by the reference numerals 8 and 9 serve to support an electric blower 10 within the electric blower chamber 5. A shielding plate 11 fabricated of steel is interposed between the rib 3 and the rubber cushion 9. A reel supporting plate 12 having an annular channel engages the rib 4. A passage 13 is defined by the reel supporting plate 12 and shielding plate 11 for introducing or guiding air flow from the electric blower chamber 5 to the exhaust chamber 7. Shown at 14 is a contact assembly which is secured, together with a reel shaft 15, to the reel supporting plate 12 by means of a screw 30. Shown at 16 is a cable reel which is rotatably supported on the reel shaft 15. Provided on the side wall of the cable reel 16 is a braking ring 19 for a brake 18 which is adapted to prevent the winding operation of an electric cable 17. Shown at 20 is a coil spring, whose one end is secured to the reel shaft 15 and whose other end is secured to the cable reel 16. The winding operation of the cable 17 is effected by means of the pre-loaded coil spring 20.

Designated by the reference numeral 21 is a transmission means which consists of a first gear 21a integrally formed on the side wall of the cable reel 16; a drive gear 22 fabricated of a synthetic resin for meshing with the first gear 21a; a face gear 24 fabricated of a synthetic resin for meshing with the drive gear 22 and turning the axial direction of rotation of a shaft 23 of the gear 22 through an angle of 90°; and a drive coupling 26 integral with the face gear 24. The respective components of said transmission means are all secured on the cable reel supporting plate 12, as shown in Figs. 4 and 5. The brake, braking ring and gears are provided in the region of one of the side walls of the cable reel.

Provided in the cable reel supporting plate 12, as best shown in Fig. 5, are an attaching hole 27 for the shaft 15 and contact assembly 14, an attaching hole 28 for the face gear 24, and an attaching hole 29 for the drive gear 22. As shown in Fig. 4, angles θ, α and lengths l_1, l_2, l_3, l_4 must be maintained to ensure engagement of the respective parts and are dependent on the accuracy with which chte cable reel supporting plate is manufactured. The contact assembly 14 and shaft 15, 16 are secured by means of a screw 30 to the cable reel supporting plate 12. Rotary shafts 23, 25, as best shown n Fig. 4, are secured to the cable reel supporting plate 12.

Turning to Figs. 1 and 2, shown at 31 is a dust indicator for indicating when the filter is clogged by dust. The dust indicator is positioned within the handle portion 2 of the case 1 by means of an indicator attaching tube 32. Shown at 33 are air exhaust openings for discharging air flow from the exhaust air chamber 7 outside the case 1. A filter 34 is positioned inwardly of the ex-

haust openings 33. The filter 34 is intended for the dual purposes of cleaning the air flow and deadening the sound, and is fabricated of a porous material such as urethane foam or the like. Shown at 35 in Figs. 1 and 2 is a dust case made of a synthetic resin, which collects therein the dust being fed through a hose not shown. The interior of the dust case 35 is divided into a rough dust chamber 37 and fine dust chamber 38 by means of a rib 36. As is clear from Fig. 1, shown at 39 is a suction port, to which is connected the hose when the cleaner is in use, and at 40 a reverse flow presentive or check valve is provided for the suction port 39. Shown at 41 in Fig. 2 is a second handle portion which is secured to the dust case 35 by means of screws 41a and 41b.

Referring to Figs. 1 and 2, shown at 43 is a movable locking member adapted to removably attach the dust case 35 to the main body case 1, by engagement of the locking member in a recess in the case 1, and the locking member 43 consists of a locking piece 43a and a spring 43b. The locking piece 43a is slidingly fitted in the second handle portion 41.

As shown in Fig. 1, a filter means 44 is removably fitted in an opening in the dust case 35, and consists of a filter 45 made of a net of synthetic resin, a filter body 46, a dust removing assembly 47 and a packing 48 for holdin gthe filter means 44.

The dust removing assembly 47 includes a dust removing clement 49 adapted to strike, upon sliding movement thereof, the back surface of the filter-body 46, a gear 50 fabricated of synthetic resin, a transmission gear 51 fabricated of synthetic resin for meshing with the gear 50, a torque receiving coupling 53 fabricated of synthetic resin and fitted on a shaft 52 of the transmission gear 51, and a supporting plate 54 having a plurality of openings or slits 54a, as seen in Fig. 12.

As indicated in Figs. 8 and 9, brake means 60 consists of the brake 18, a lever 62 on which the brake is mounted so as to allow pivotal movement of the brake 18, a spring 63 for pulling the lever 62 in the direction of an arrow Po, and a braking wall 65 which defines a space 64 together with the braking rnig 19 and is adapted to brake the cable reel 16 with the aid of the braking ring 19 with the brake 18 maintained therebetween i.e., in the space 64. Shown at 66 is a screw for securing the braking wall 65 to the main body case 1, and at 67 a pedal for effecting pivotal movement of the brake 18 about a pin 68. The pivotal movement of the brake 18 together with a slight movement in the direction of an arrow Qo releases the cable reel 16 from the braked condition to wind the cable 17 therearound.

As shown in Figs. 10 and 11, the packing 48 includes a peripheral packing portion 48a which is fitted around the filter body 46, thereby removably holding the filter means 44 against the dust case 35 in air tight relation; and a packing portion 48b interposed between the supporting plate 54 and a front wall 1c of the case 1.

The packing 48 serves to efficiently seal the dust case 35 so that the dust is carried by the air flow which has been produced due to a vacuum or negative pressure P2 produced within the dust case 35, rather than due to the atmospheric pressure P1, outside the dust case, when the dust case 35 is attached to the case 1 and the electric blower 10 is maintained in operation.

Referring to Fig. 18, a striking portion 49a of the element 49 is formed by bending the end of a wire such as a piano wire into an arcuate or circular form, and the remaining portion of the wire serves as a dust removing body portion 49b. The other end of the dust removing body portion 49b is bent into a screw-retaining circular portion 49c. The dust-removing element 49 is secured to the gear 50 by securing the screw-retaining portion 49c to the gear 50 by means of a screw 70. Provided on the striking portion 49a is a protective material or sleeve 49d made of a resilient resin or the like.

Shown at 53a in Figs. 6 and 7 is a projection formed on the torque receiving couplink 53, while the outer peripheral edge of the projection 53a is chamfered in view of safety in the case that the projection is exposed while rotating. Shown at 69 is a pin which has been press fitted in the shaft 52 for transmitting a drive torque by engaging a radially inwardly projecting rib 53b. Shown at 26a is a groove defined in the drive coupling 26, while the projection 53a is fitted in the groove 26a to thereby transmit a torque. In addition, the edge 26b of the groove 26a, although not shown in Fig. 6, is chamfered in view of safety, while the width of the groove 26a is set to less than 10 mm so as not to allow a finger to be inserted therein. The outer peripheral portion 26c of the drive coupling 26 is chamfered in view of safety in case the coupling is exposed while rotating and for facilitating the engagement between the driven coupling 53 and the drive coupling 26 upon installing the dust case 35. The coupling 53 is provided with a second projection 53c also engageable with the groove 26a.

In Fig. 7, 'J' represents an axis of rotation of the driven coupling 53, 'H' an axis of rotation of the drive coupling 26, and δ a deviation between the both axes of rotation J and H which has been caused by the sum of the dimensional tolerances of the respective parts. 'G' represents a locus described by the tip 'F' of the projection 53a at the time of the attachment or removal of the dust

case 35, and 'ε' represents the maximum deviation of the tip 'F' in the upward direction in Figure 1. The difference in width between the projection 53a and the groove 26a is determined so as to be larger than twice the sum of 'ε' and 'δ'. As a result, there may not take place an excessive loss of torque and damage to the dust case 35 to the deviation 'δ' between the axes of rotation 'J' and 'H'.

Upon attachment of the dust case 35 to the main body case 1, the driven coupling 53 is placed so as to abut the drive coupling 26 from above obliquely. However, the driven coupling 53 is readily fitted to the drive coupling 26 because of the chamfered outer peripheral portions 26c and 53c (Figure 6), while compressing the spring 57, thereby bringing the dust case 35 into engagement with the main body case 1. Thereafter, the driven coupling 53 is rotated in an idle condition until the position of the projection 53a coincides with the position of the groove 26a. Thus, a torque can be transmitted thereafter.

The dust removing assembly 47 is positioned in the rear of the filter body 46. The gear 50 is rotatably mounted on the supporting plate 54 and mounts thereon the dust removing element 49 adapted to slide on the rear surface of the filter body 46.

A rotary disc 55 is secured to the hub portion 50a of the gear 50 by means of a screw 55a and integrally mounts a knob 56 thereon. The dust removing knob 56 is manually operable to rotate the gear 50 and thus element 49 only when the dust case 35 is removed from the main body case 1.

The transmission gear 51 is rigidly secured on the shaft 52 by press-fitting or by means of a screw, and mounted on the supporting plate 54 in such a manner as to mesh with the gear 50.

The engagement of the driven coupling 53 with the drive coupling 26 within the main body case 1 permits turning force of the cable reel 16 to be transmitted to the dust removing element 49 by way of gear 21, drive gear 22, face gear 24, drive coupling 26, driven coupling 53, transmission gear 51, and gear 50, so that the dust removing element 49 is rotated to rub the rear surface of the filter body 46. Shown at 58 are travelling wheels mounted on the case 1, and at 59 is a travelling wheel mounted on the dust case 35.

As shown in the drawings, assume N_1 as the number of teeth of the gear 21 mounted on the cable reel 16, N_2 as the number of teeth of the drive gear 22, N_3 as the number of teeth of the face gear 24, N_4 as the number of teeth of the transmission gear 51, and N_5 as the number of teeth of the gear 50. Then, the rotational speed of the hub portion 50a of the gear 50 can be driven by multiplying the rotational speed of the rotary shaft 15 of the cable reel 16 by

$$\frac{N_1 \times N_4}{N_3 \times N_5}.$$

Accordingly, if the value of

$$\frac{N_1 \times N_4}{N_3 \times N_5}$$

is less than 1, then the rotational speed of the gear 50 is less than that of the cable reel 16.

In practice, in order that the reduction transmission described can be obtained it is necessary to accomodate the transmission means 21 and the dust removing means 47 within the case 1 and the dust case 35, respectively. Therefore it is desirable to render the value of

$$\frac{N_1 \times N_4}{N_3 \times N_5}$$

between 1/2 and 1/5. In the most preferred embodiment, the numbers N_1, N_2, N_3, N_4 and N_5 of teeth of the respective gears are 53, 13, 41, 13 and 70, respectively.

The filter body 46 consists of a pleated filter medium 46a, and a frame body 46b made of synthetic resin and holding the pleated filter medium 46a. Provided in the groove portions of the pleats the pleated filter medium 46a, i.e., on the side of the filter (the front side) opposite to that which is rubbed by the dust removing element 49, and in the apices defining the ridges 46c of the pleated filter medium 46a, are spacers 71 having a triangular cross section and made of synthetic resin. As shown in Fig. 13, there are provided reinforcing members 46d on the ridges of the pleats of the pleated filter medium 46a on the front side of the filter medium 46a.

The spacers 71 and the reinforcing members 46d are connected by connecting ribs 46, as best shown in Figs. 12 to 14.

Shown at 72 (Fig. 3) is a plug for an electrical supply, which is secured to the end of the electric cable 17, and shown at 73 is a cover for an opening 74 for drawing out the cable 17 therethrough. A transparent cover 75 for the dust indicator 31 is positioned in the first handle portion 2.

The cable reel 16 includes upper and lower side plates 16a, 16b which are secured one relative to the other by means of a screw 76.

A condenser 77 is secured to the electric blower 10 by means of a supporting piece

78 and a screw 79. A carbon brush is designated by the reference numeral 80.

Shown at 81 is a screw which couples together the lefthand and righthand portions 1b and 1a, and at 82 a change-over switch secured to the rear, top surface of the main body case 1 by means of a metal piece 83 to select either of the power supply settings 450 watt and 600 watt.

Wheel 59 is attached to the undersurface of the dust case 35 by means of a support plate 84, washer 85, screw 86 and nut 87. A check valve 40 is attached in position in the air intake opening by means of a screw 88. An air intake opening cover 90 is attached to the front surface of the dust case 35 by means of a screw 89. A packing 91 is used for sealing between the intake air-opening cover 90 and the dust case 35. A lead wire 92 is provided for the remote control of a manual switch (not shown) provided on a hose to be inserted into the intake air opening 39. The lead wire 92 is received within the second handle 41. Shown at 93 is a remote control relay for operating the electric blower 10, and at 94a, 94b, 94c and 94d silencing members positioned on the outer periphery of the electric blower 10 and made of a flame proof material. Shown at 95 is a projection of the case 1.

With the above - mentioned arrangement, when the electric blower 10 is operated, then the dust which has been introduced through the air intake opening 39 is removed by or remains on the net filter 45 and filter 46. The air flow which has passed through the filter 46 travels through the exhaust air chamber 7 and through the exhaust opening 33 to the outside of the main body case 1, while cooling the electric blower 10 on its way through the cleaner. The larger dust particles are collected in the dust chamber 37 by means of the net filter 45, while fine dust is collected in a fine dust chamber 38 by means of the filter body 46.

The drawing out or winding of the cable 17 causes the cable reel 16 to rotate. The rotation of the cable reel 16 is transmitted to the dust removing element 49 by way of first gear 21, drive gear 22, face gear 24, drive coupling 26, driven coupling 53, transmission gear 51, and gear 50, thus rotating the dust removing element 49.

The dust removing element 49 rubs the back surface of the filter body 46 during its rotation, so that the dust clinging to the filter body 46 drops into the fine-dust chamber 38.

As a result of the reduction transmission described above the torque required to wind the coil spring 20 can be relatively small. Therefore, the shaft of the gear 50 for rotating the dust removing element 49 produces a torque, of which amounts to

$$\frac{N_3 \times N_5}{N_1 \times N_4}$$

that is, approximately 4.2 in the case of the most preferred embodiment times the torque of the reel shaft 15 of the cable reel 16, so that the torque produced on the reel shaft 15 of the cable reel 16 may be approximately 1/4.2 times the torque on the shaft of the gear 50. Accordingly, the coil spring 20 as mentioned above produces a relatively small torque, sufficient to wind the cable 17, in addition to a torque amounting to approximately 1/4.2 times the torque produced on the shaft of the gear 50.

In contrast thereto, Fig. 19 shows a prior art cable reel assembly, wherein the rotation or turning force of the reel 160 is transmitted through a first gear 210 to a drive gear 220 and then to the ratchet type coupling 260. Then, the rotation is transmitted from the coupling 260 to the ratchet type coupling 530 which is so designed as to rotate only in one direction by means of a coupling spring 410, then from the coupling 530 to a mount 550 mounting the dust removing element 490 thereon, for turning the mount 550. In this case, assume Na as the number of teeth of the gear 210, and Nb as the number of teeth of the drive gear 220, and the value of Na/Nb is larger than one. Then, for rotating the dust removing element 490, a torque required for the reel shaft of the cord reel 160 should be Na/Nb times the torque required for rotating the dust removing element 490. As a result, the torque to be produced by the coil spring will be considerable.

Referring to the present invention assume T_1 as the torque required for winding the cable 17, and T_2 as the torque required for rotating the dust removing element 49. Then, the torque T_0 to be produced by means of the coil spring 20 in the most preferred embodiment of the present invention and a torque T to be produced by means of the prior art coil spring are given as follows:

$$T_0 = T_1 + (1/2 \text{ to } 1/5) \times T_2$$

$$T = T_1 + (\text{one or more than one}) \times T_2.$$

As can be seen from this, the torque T_2 required for rotating the dust removing element 49 is small as compared with the torque T_1 required for winding the cable 17. As a result, the preferred embodiment shown permits the dust removing element 49 to be operated without the need of substantially increasing a torque to be produced by the coil spring 20 either in the drawing out direction or in the winding direction of the cord 17.

As is apparent from the foregoing, as the

dust removing element 49 slides over the back of the filter medium 46a it strikes the ridges 46c of the pleats of the filter medium 46a in the both directions, as shown in Fig. 17, in one direction upon winding and in the opposite direction upon drawing out the cable 17, so that the ridges 46c of the pleats of the filter body 46 will not be permanently deformed. In this respect, the prior art discloses a dust removing element in which, if applied to the most preferred embodiment, ridges 46c of the pleats of the filter body 46 would be hit by the dust removing element only in one direction, so that the repetition of such an operation leads to tthe deformation of the ridges 46c with the result that the dust removing element will fail eventually to strike the ridged portions of the pleats sufficiently.

Referring again specifically to the preferred embodiment of the present invention, a suction force whose level is lowered down to a point X after the cleaning operation as shown in Fig. 20 may be recovered to a point Y according to the winding operation of the cable 17, and then further recovered to a point Z according to the drawing out operation of the cable 17 at the start of the cleaning operation. As a result, the cleaning operation may be started under a strong suction force.

In addition, if the cable 17 is wound after the completion of the cleaning operation, then the dust clinging to the filter body 46 may be automatically removed.

In the normal operation, the dust removing operation is carried out automatically by winding and drawing out the cable 17 in the normal cleaning operation, presenting a characteristic as shown by a curve 'U' in Fig. 21. A curve 'W' in Fig. 21 represents the characteristic in the case of the dust removing operation which is carried out only manually. The comparison of the curve 'U' with the curve 'W' reveals that the 'U' curve allows the collection of dust of a much more amount as compared with the curve 'W'. In other words, the curve 'U' allows the cleaning under a strong suction force, in terms of the same amount of dust being collected. However, in case the filter body 46 is clogged, then a suction force may be available only up to the point X in Fig. 21.

In such a case, the movable locking member 43 is unlocked, so that the dust case 35 may be removed from the main body case 1. As a result, the dust removing assembly 47 may be separated from the transmission assembly 21 along the line Q_1—Q_1' in Fig. 16, so that the dust removing knob 56 becomes exposed. Then, the dust removing knob 56 is rotated, so that the dust removing element 49 may hit the ridges 46c of the corrugations of the filter body 46. In this manner, the suction force can be recovered to the point X3 in Fig. 21.

In the preferred embodiment of the present invention, when the dust removing knob 56 is rotated, the transmission gear 51 and the driven coupling 53 remain idling, so that the dust removing element 49 may be rotated with ease.

When the striking portion 49a and the dust removing body portion 49b are placed in parallel with the surface of the filter body 46, then the distance from the filter body 46 to the dust removing body portion 49b is shortened by the width of the striking portion 49a, as compared with the prior art arrangement, wherein the portion corresponding to the striking portion 49a is positioned effectively between the filter 46 and the dust removing body portion 49b. In other words, the dust removing assembly 47, electric blower 10 and cable reel 16 may be placed closer to each other by the width of the striking portion 49a. As a result, the cleaner case consisting of the main body case 1 and the dust case 35 may be rendered smaller in size than that of the conventional cleaner case. Particularly in case the dust removing element 49 is made of a wire as in the most preferred embodiment according to the present invention, the width of the striking portion 49a of a bent wire will be only the distance from the filter 46 to the dust removing body portion 49b, so that the size of the cleaner case may be rendered smaller in size. In addition, the dust removing element 49 is formed by simply bending a wire, so that the manufacturing steps are much simplified. Since the protective material covers the end portion of the dust removing element 49, the damage and wear in the filter body 46 may be prevented.

As shown in Fig. 23, if the filter is bent into a pleated shape having sharp corners as in the filter 460, the relatively small-sized dust would be caught in the groove portions of the pleats. In contrast thereto, as shown in Figs. 22 and 24, the filter body 46 shown has spacers 71 in the groove portions of the pleats so that there is no risk of dust 99 being caught in the groove portions of the pleats, but the dust tends to cling to the side surface of the groove portions or drops into the fine-dust chamber 38 in the dust case 35.

In addition, if the dust removing element 49 hits or rubs the back surface of the filter body 46 where there are no spacers 71, then there arises a possibility of cracking or tearing in the top edge portions of the pleats as on the back surfaces of the prior art filter body 460. In contrast thereto, as shown in Figs. 22 and 24, with the filter body 46 having spacers 71, if the filter surface wears to a depth of X4 as shown in Fig. 24, then there results only exposed spacers 71, presenting

no possibility of causing cracking, holes or tears in the surface of the filter body 46. In addition, the spacers 71 protect the pleated filter medium 46a from wear and damage due to the rubbing motions of the dust removing element 49, while the reinforcing member 46b protects the pleated filter 46a from damage due to inadvertent excessive force of the user. In other words, in the case of the prior art arrangement as shown in Fig. 25, if an external force P_3 is exerted on the top edge portions of the pleats of the filter 460, then there is created an abnormal stress in the joint portion between the filter 461 and the holding frame 462, thus leading to cracking 463 in the filter 461 made of paper and having a low mechanical strength. In contrast thereto, in the case of this embodiment of the present invention as shown in Fig. 15, even if an external force P_4 is applied to the filter, the reinforcing member 46d is deformed elastically, thereby preventing the creation of the abnormal stress in the joint portion between the pleated filter medium 46a and the frame body 46b, with the resulting prevention of the filter 46 from damage.

On the other hand, if the filter body 46 is exposed to moisture, the filter body expands linearly, so that the pleated filter 46a is bent or wrinkled and fails to achieve an efficient dust removing effect. In the embodiment of the present invention, however, the spacers 71 and reinforcing members 46d absorb the moisture and thus prevent the linear expansion of the filter, thereby preventing the waving phenomenon or wrinkles of the pleated filter.

As shown in Fig. 14, the spacers 71 and reinforcing members 46d are placed on the same side of the filter 46, so that the reinforcing members 46d and frame body 46b may be molded integrally by using a plastics material. In the manufacture of such an arrangement, as shown, an inlet 100, through which the plastic material is injected, may be provided only in a cavity for the reinforcing member 46d, thus allowing the molding of the both spacers 71 and the reinforcing members 46d. This eliminates the necessity of providing in addition to the inlet 100 an inlet to be positioned in the cavities for groove portions, in a casting mold. As a result, productivity can be much improved, without the need of providing so many inlets 100.

Still furthermore, as shown in Fig. 4, the cable reel 16 and the transmission components associated therewith are provided as one block, or a sub-assembly, so that these components may be built in the main body case 1 with ease, but without the risk of the transmission components becoming out of engagement.

Referring again specifically to the embodiment of the present invention, the dust case 35 is installed on the case 1, in engagement with the integral projection 95.

After the projection 95 is in position the movable locking member 43 is engaged. However, the drive and driven couplings are located close to the projection 95, so that there is no possibility of these couplings being damaged, due to their engaging each other at low speed. Furthermore, this facilitates the alignment of the both axes of rotations at the time of engagement of coupling, thus minimizing the loss in torque in the coupling and providing positive transmission or torque.

As is apparent from the foregoing description, the vacuum cleaner according to the present invention permits efficient dust removing operations both upon drawing out and winding the cable from and around the cable reel.

WHAT WE CLAIM IS:—

1. A vacuum cleaner comprising a dust case having an air-intake opening; a main body case having an air exhaust opening; means for releasably locking together said dust case and said main body case; a filter received within said dust case; an electric blower received within the main body case and adapted to introduce an air flow into said air intake opening through the filter and out of the air exhaust opening; an electric supply cable reel received within said main body case and biased in a winding direction by means of a coil spring; a dust removing means for removing the dust clinging to said filter; and a transmission means for transmitting motion of said cable reel, produced upon winding and drawing out said cable, to said dust removing means; said dust removing means having a dust removing element which rotatively slides on a back surface of said filter to remove the dust clinging to said filter, the transmission means and the dust removal means being constructed such that the rotational speed of said dust removing element is smaller than that of said cable reel.

2. A vacuum cleaner as claimed in Claim 1, further comprising means for manually rotating said dust removing element independently of said cable reel.

3. A vacuum cleaner as claimed in Claim 1, wherein said dust removing element consists of a striking portion for striking ridged portions of a pleated filter medium of said filter, and a body portion for supporting said striking portion, and said striking portion and said body portion being juxtaposed on the back surface of said filter.

4. A vacuum cleaner as claimed in Claim 3, wherein said striking portion comprises a bent end of a wire, and the remaining part of said wire constitutes said body portion.

5. A vacuum cleaner as claimed in Claim

4, wherein said striking portion is provided with a sleeve.

6. A vacuum cleaner as claimed in Claim 1, wherein said filter comprises a pleated filter medium and a frame member for supporting said pleated filter medium.

7. A vacuum cleaner as claimed in Claim 6, wherein there is provided a spacer member in a groove portion of the pleats on the surface of said pleated filter medium opposite to the surface engaged by said dust removing element of said dust removing means.

8. A vacuum cleaner as claimed in Claim 7, wherein there is provided a reinforcing member for each ridge portion of the pleats on the surface of said pleated filter medium opposite to the surface engaged by said dust removing element of said dust removing means, and wherein said reinforcing members are formed integrally with said frame member.

9. A vacuum cleaner as claimed in Claim 1, further comprising drive and driven couplings which cooperatively transmit motion of the cable reel to said dust removing means only when said dust case is locked with said main body case.

10. A vacuum cleaner as claimed in Claim 9, wherein said driven coupling is mounted on the dust removing means, and said drive coupling is part of the transmission means, and wherein said driven coupling is resiliently mounted.

11. A vacuum cleaner as claimed in Claim 1, wherein said transmission means comprises a gear provided on the side wall of said cable reel; a drive gear for meshing with said gear; a face gear for meshing with said drive gear in such a manner as to change the axial direction of rotation through an angle of 90°; and a drive coupling integrally formed on a rotary shaft of said face gear; and wherein said dust removing means comprises said dust removing element, a further gear to which said dust removing element is attached; a transmission gear for meshing with said further gear; and a driven coupling mounted on the shaft of said transmission gear and adapted to engage said drive coupling.

12. A vacuum cleaner as claimed in Claim 9, comprising a packing for sealing between said filter and dust case.

13. A vacuum cleaner as claimed in Claim 11, wherein the respective components constituting said transmission means are all mounted directly or indirectly on a support plate which is mounted within said main body case and which supports said cable reel.

14. A vacuum cleaner as claimed in Claim 9, further comprising a projection on the main body case for locking said dust case to said main body case, and said drive and driven couplings being positioned in the region of said projection.

15. A vacuum cleaner as claimed in Claim 11, further comprising a brake pivotally mounted on the main case and being engagable with a braking ring for braking said cable reel against the winding force of said spring, and said brake, braking ring and said gears being provided in the region of one of the side walls of said cable reel.

16. A vacuum cleaner substantially as herein described with reference to Figures 1 to 18, 20 to 22 and 24 of the accompanying drawings.

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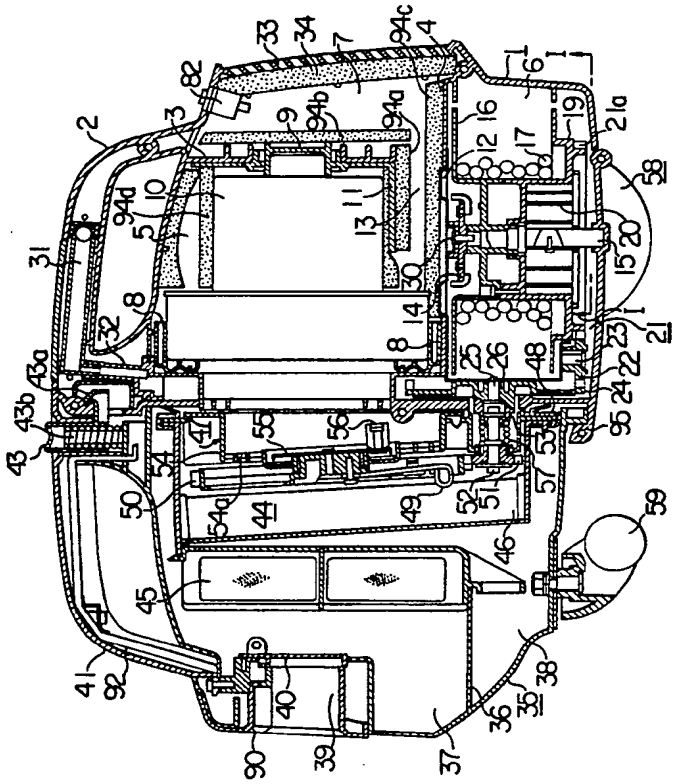
Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1978
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1504063 COMPLETE SPECIFICATION

13 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

FIG. 1



1504063 COMPLETE SPECIFICATION
13 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

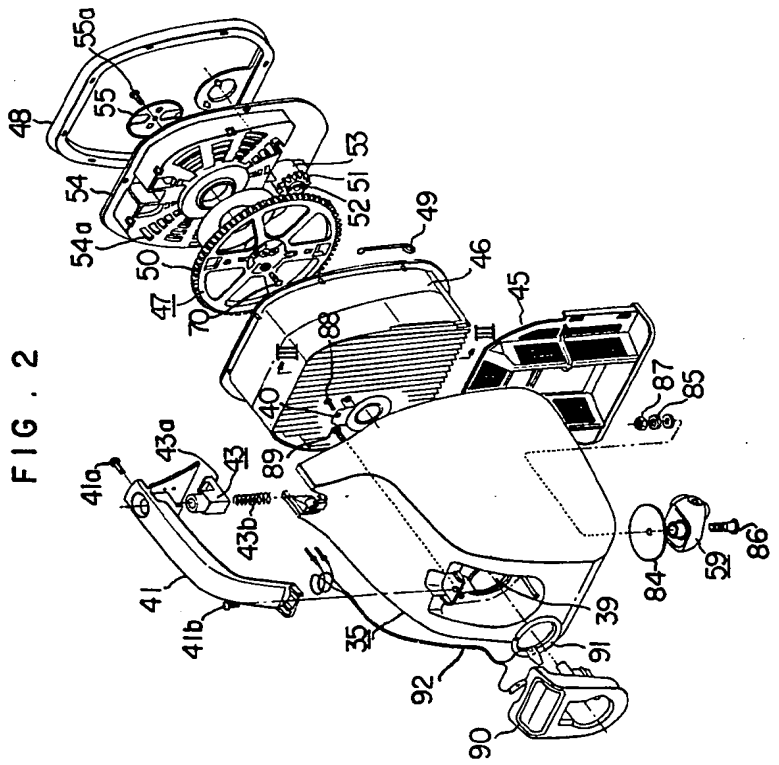


FIG. 2

FIG . 4

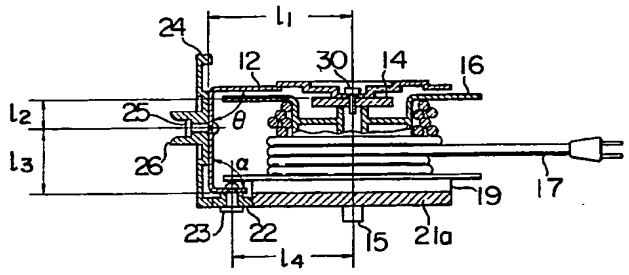
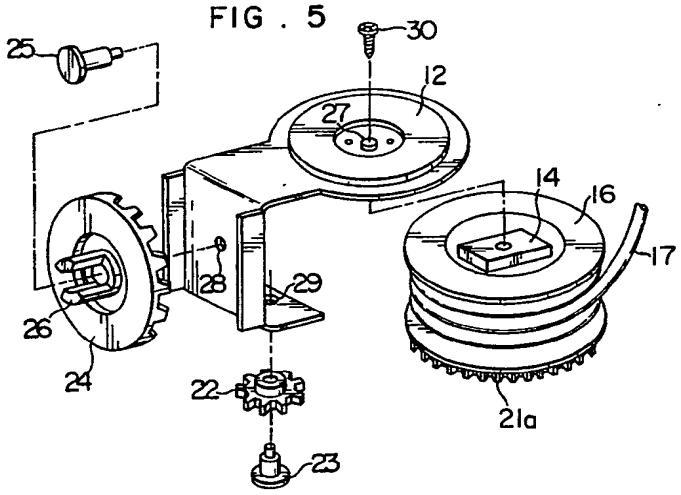


FIG . 5



1504063 COMPLETE SPECIFICATION
13 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 3

FIG. 3

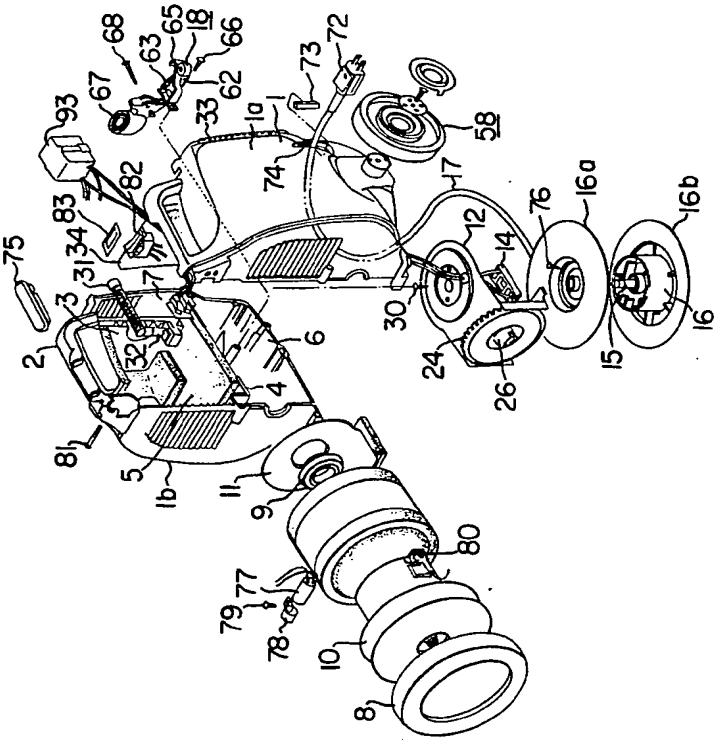


FIG. 8

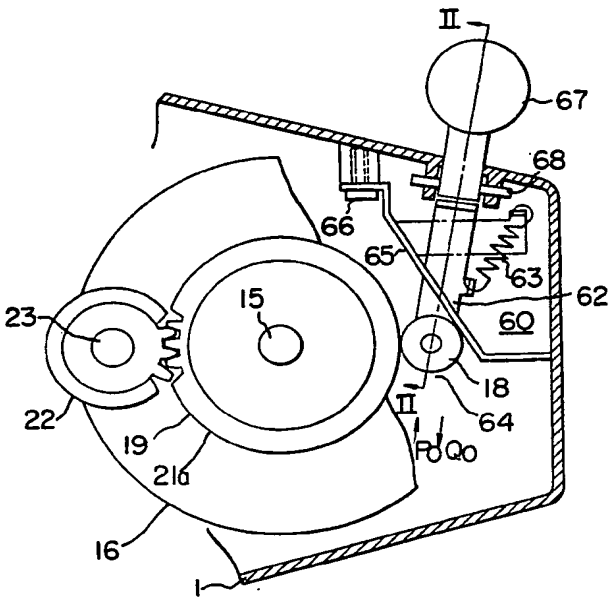


FIG. 9

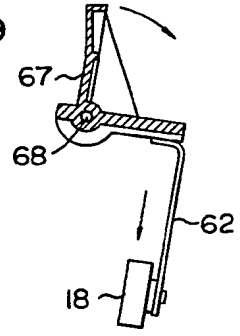


FIG . 6

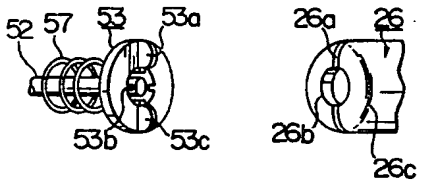


FIG . 7

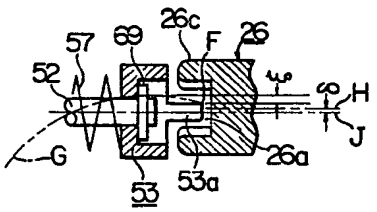


FIG . 12

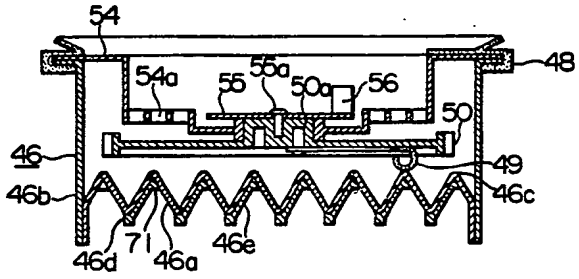


FIG . 13

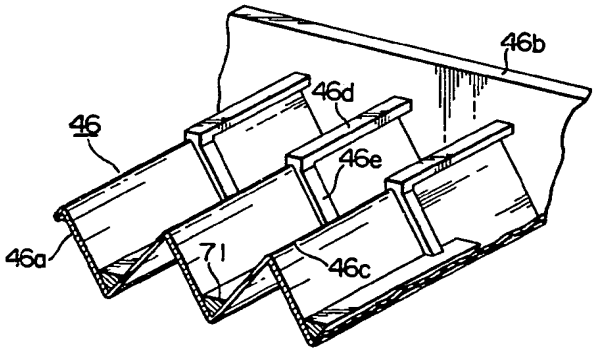


FIG. 10

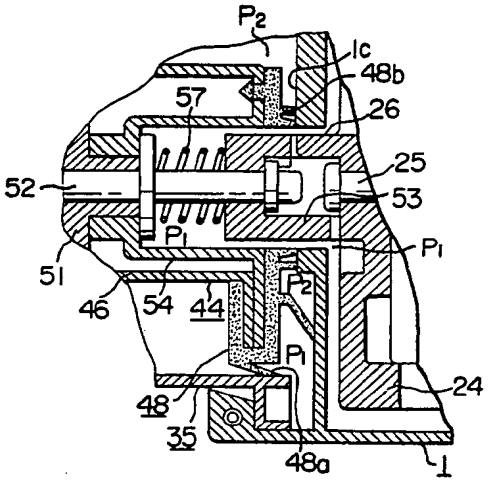


FIG. 11

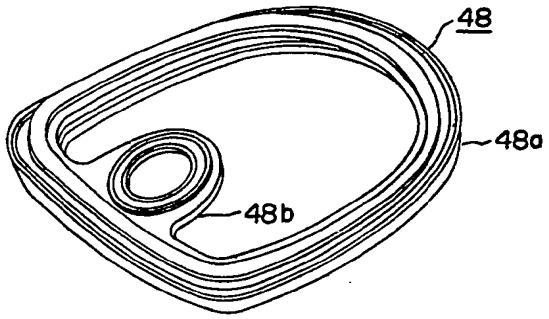


FIG . 16

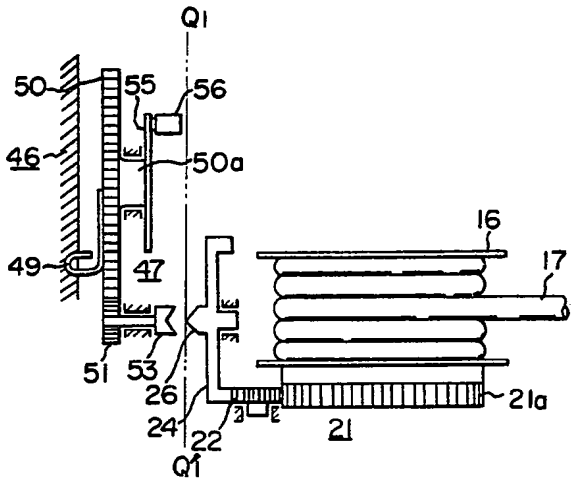


FIG . 17

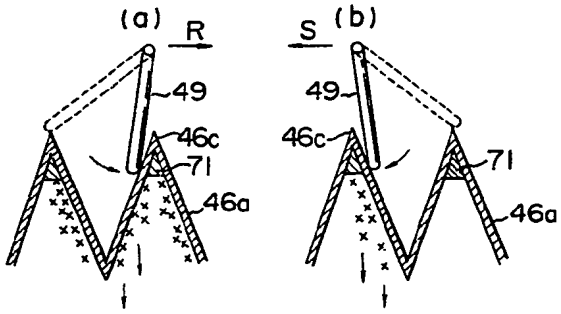


FIG. 14

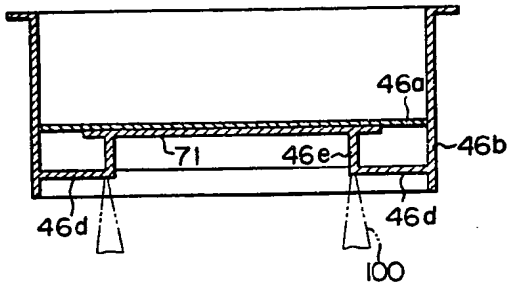


FIG. 15

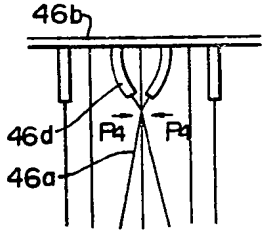


FIG. 20

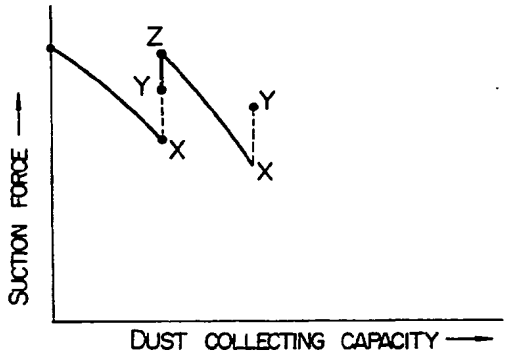

Z
Y
X
Y
X
SUCTION FORCE
DUST COLLECTING CAPACITY

FIG. 21

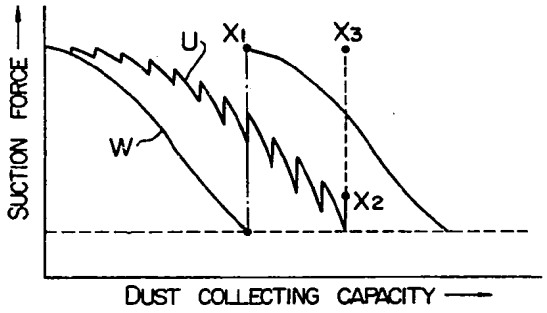

U
X1
X3
W
X2
SUCTION FORCE
DUST COLLECTING CAPACITY

FIG. 18

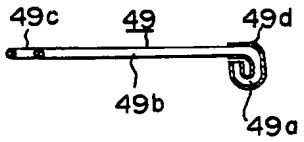


FIG. 19

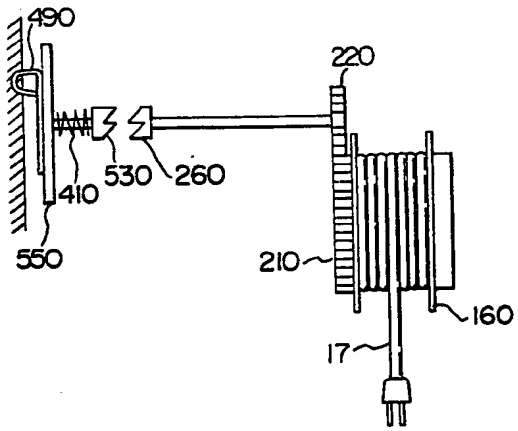


FIG. 22

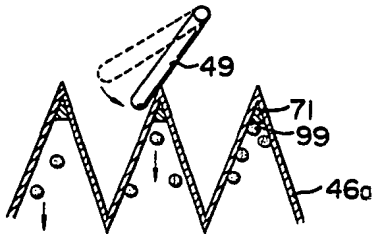


FIG. 23

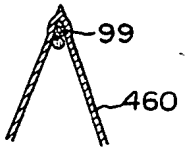


FIG. 24

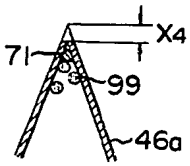


FIG. 25